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PEOPLE ORGANIZATIONS AND COMMUNICATIONS

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NATIONAL SYMPOSIUM ON GLOBAL COMMUNICATIONS

Washington, D. C.

August 1-3 1960

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**THE FRANKLIN INSTITUTE**  
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 ABSTRACT

Military communication systems are designed to convey information from its point of origin as human thought through its dissemination to the points of action. Current equipment development programs should aim at an optimum relationship between humans and automatic equipment. Consequently, determination of the factors associated with the inter-relationship of people, communication methods, and organizational concepts must constitute a fundamental element of system analysis and design.

 This paper deals with the development of a methodology for assessing the effectiveness of the human and organizational elements in military communication networks in terms of a trade off between the control of error and the delay involved in error control. Since all information to be transmitted by the system does not inherently require equal freedom from error and delay, an information characterization scheme is introduced. Information is characterized in terms of its (a) urgency, (b) importance, and (c) policy status. Delay and error control are then measured and examined as functions of these information characteristics. Conceptually, messages are considered to flow from source commander to destination commander, with the action officers, releasing officers, staff message agencies, and the like considered as system elements. Total error and delay, and their interactions, are then measured from commander to commander. Individual error components are postulated to permit evaluation of the effectiveness of specific message processing phases, such as preparation, coordination, review, and release.

Problems involved in the collection of data in an operating army headquarters and the development of specific instruments for route tracing and communications error and delay measurement are discussed in some detail.

Preliminary field trials of the model are discussed.

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## PEOPLE ORGANIZATIONS AND COMMUNICATIONS\*

Command control has become a by-word in expressing the need for responsive military communications. The execution of command control has been construed by many people as the need for a direct line between commanders where the terminating instruments are to be located in physical proximity to the commander. As a result, considerable emphasis in recent months has been given to the engineering and installation of a relatively small number of channels, but placed directly between commanders. This type of service facilitates personal contact between commanders, and thereby improves command control; however, military operations cannot be conducted by commanders alone, but require a rather extensive supporting staff function. This staff function requires communications of considerable volume between Command Headquarters. Not only does this staff operation require volume between headquarters, but it requires an efficient message collection and distribution system within headquarters. This particular area, that is, provision of an efficient local collection and distribution system, has not received the same amount of attention as long line circuit improvement. The problem of providing such an efficient system is rather complex, since it deals with human relationships,

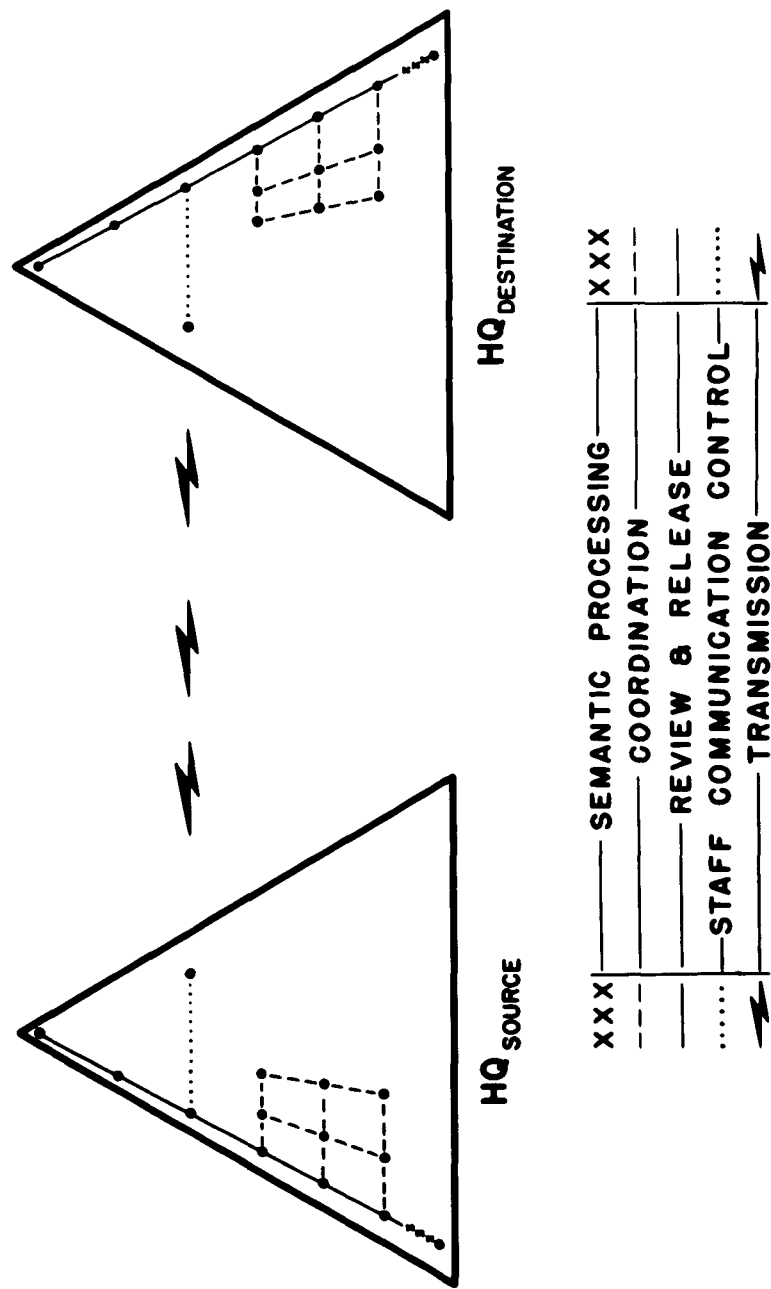
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\*The research described in this paper was conducted under Department of Army Contract DA-36-039-SC78332 administered by the Army Communications Systems Division, Office of the Chief Signal Officer.

and an interface between humans and machines. Technically speaking, automation capabilities have made it possible to design a local communication system which would provide direct access by every staff officer. From an operational viewpoint, there are aspects of this technical possibility which are desirable, and there are other aspects which are quite undesirable. There are questions of degree of automation, of choice of subscriber equipments, and of number and location of subscriber units which depend on a rather precise understanding of the internal Headquarters communication system. To meet this need, the U. S. Army and the Franklin Institute have undertaken an Operations Research Study of Army Headquarters Communication. The basic objective of this program is, then, the determination of the fundamental principles of the inter-relationship of people, organizations, and communications. This paper will present a necessarily brief report on the development of our approach to this problem.

We may begin by briefly reviewing a typical, local, collection and distribution system in a non-tactical communications network, as is indicated in Figure 1.

The communication originates as a thought in the mind of an action officer who desires to communicate with his opposite number at another headquarters. The first system element is semantic processing; in this case, encoding - the conversion of thought to language. The next element is coordination - the processing of the communication in an essentially lateral fashion for concurrence and information of other interested staff



**ARMY COMMUNICATION PROCESS**  
**FIGURE I**

elements. Next, we have review and release - the approval of the communication by the action officer's superiors, in some cases, up to the commander himself. The next element we term staff communication control - the processing of the communication by organizational segments, specifically charged with communication control, such as the Adjutant General. Finally, we reach the inter-headquarters transmission element - traditionally the bailiwick of the communicator, but interestingly enough, only a small fraction of the total communication process. When the communication arrives at the destination headquarters, it must traverse the entire sequence of elements, in reverse, until it terminates as thought in the mind of the destination action officer. From this description of the process, it can be seen that headquarters internal elements constitute a significant portion of the total network, and are, indeed, often the principal factor in total transmission time. It is clear that we can no longer ignore them in our quest for improved communications systems. As a matter of fact, for truly effective systems synthesis, we must furnish our engineers with the operating characteristics of these human and organizational elements in much the same fashion as engineering handbooks provide vacuum tube operating characteristics. The development of operating characteristics of elements which represent a complex interaction of humans, organizations, and communications media, is a difficult and challenging task, but one whose payoff is potentially great.

In determining such characteristics, two general criteria seem appropriate for overall system or individual elements, shown in Figure 2. If we consider the objective of the system to be the transmission of information (we use the word quite loosely in its general sense) from source to destination, our first criterion is delay. We compute delay as:

$$T_{\text{destination}} - T_{\text{source}} = D \text{ (Delay)}$$

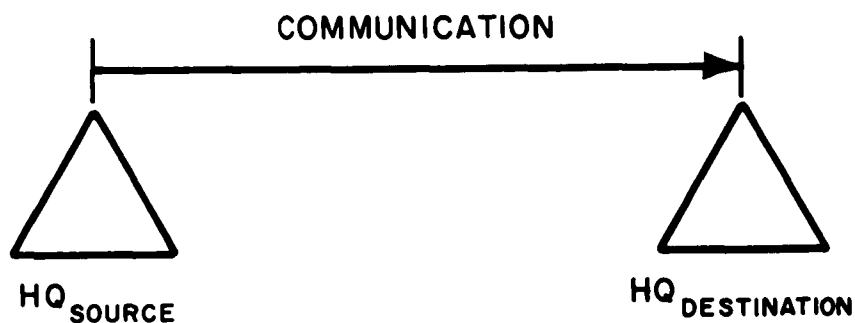
Our second criterion is error. We compute error in like manner as:

$$I_{\text{destination}} - I_{\text{source}} = E \text{ (Error)}$$

A perfect system would then be one in which the identical information is simultaneously available at both point of origin and destination.

In the case of military communication systems, it is necessary that we expand this criterion system somewhat. We may recall that neither the source nor destination action officers are operating as individuals, but rather as portions of complex entities we term military staffs, and that in exchanging a communication, they are actually acting for their respective commanders. This suggests the extension of our criterion as indicated in Figure 3.

Consider first the middle block on the left, the action officer's thought. Under presently available techniques, he may convert this to either spoken or written language - the Action Officer's output block. This output is transmitted to the destination headquarters where it finally arrives as the input to the destination Action Officer, from



COMMUNICATION = TRANSFER OF INFORMATION

CRITERIA

$$T_{\text{DESTINATION}} - T_{\text{SOURCE}} = D$$

$$I_{\text{DESTINATION}} - I_{\text{SOURCE}} = E$$

WHERE

I = INFORMATION

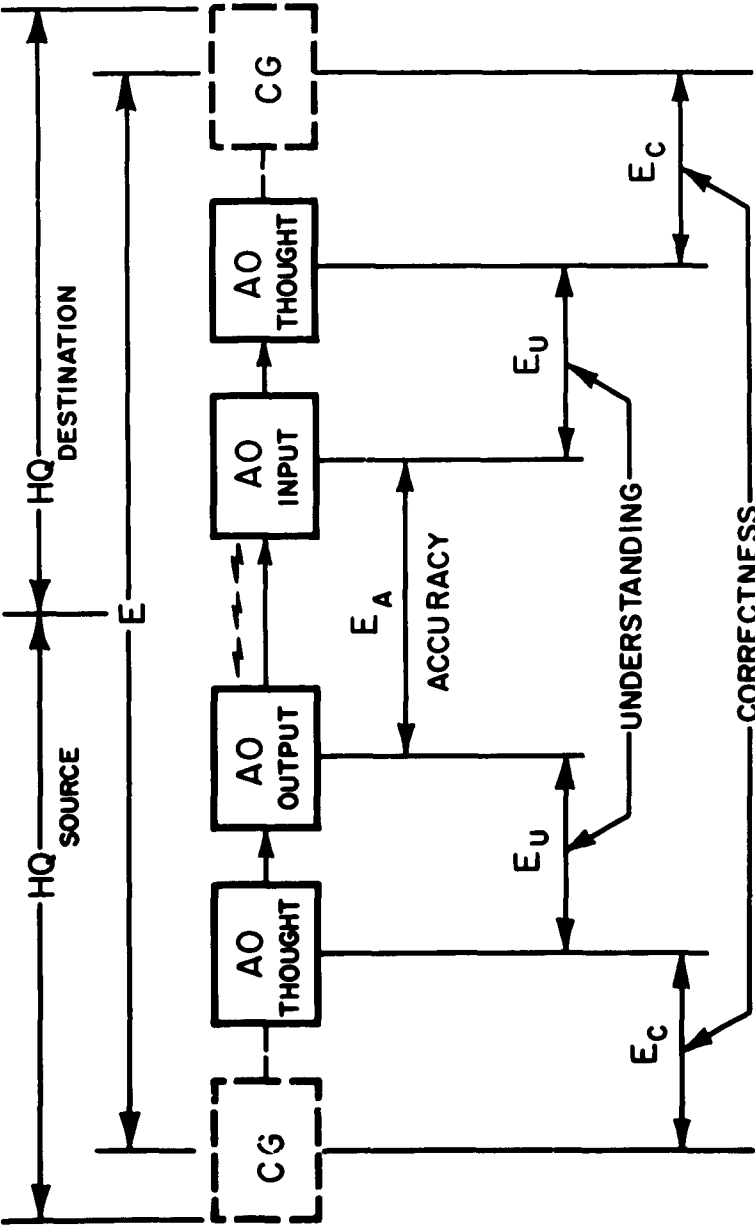
T = TIME

E = ERROR

D = DELAY

GENERALIZED COMMUNICATION MODEL

FIGURE 2



$$E = E_A + E_U + E_C$$

ARMY COMMUNICATION MODEL

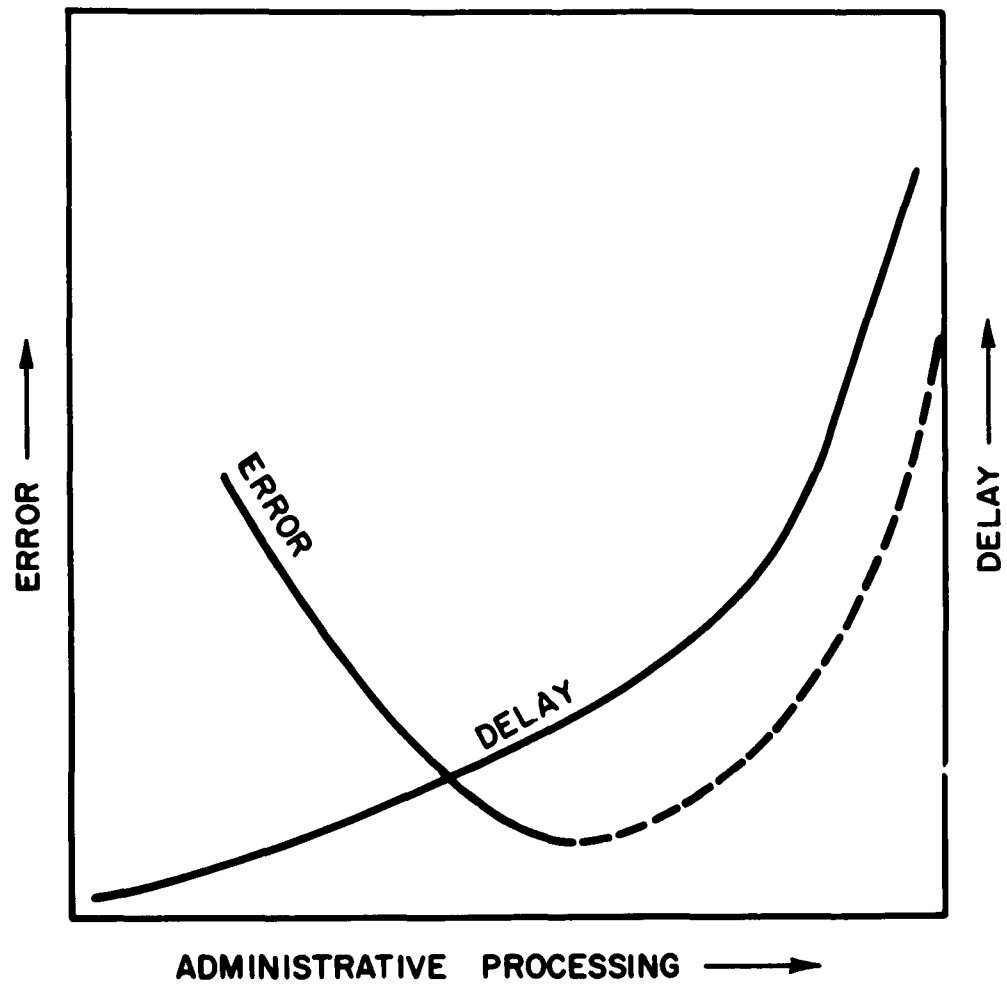
FIGURE 3

which it is converted to thought. The first aspect of the total Error we term  $E_A$  (Error of accuracy). This is merely a measure of the congruence between the originating Action Officer's output, and the destination Action Officer's input. Errors of this type tend to be infrequent, and are relatively easy to control: for example, in the Army Command and Administrative Net, we transmit numbers and difficult words twice. Indeed, for certain systems, say the U. S. mail, where the output and the input are the identical piece of paper,  $E_A$  is virtually zero. We are all familiar, however, with the case of zero  $E_A$  (Error of accuracy), yet of almost complete lack of congruence between source and destination thought. The semantic decoding and encoding elements were not operating properly. To put it quite simply, either the writer couldn't write, or the reader couldn't read. We term this  $E_U$  (Errors of understanding) and suggest that they are of vital importance in this global communications business. The third and last segment of error is indicated by the dashed blocks on either end of the figure. Recalling that the Action Officer writer is, in effect, representing his commander, it is essential that there be congruence between the Action Officer's thought and the commander's thought, were the commander to be aware of the specific communication. Indeed, most of the administrative processing of military communication is designed to do precisely this.

Having stated our criteria, it is now possible to suggest a general means for evaluating the efficacy of individual elements by

examining the trade-off between delay and error. Thus, administrative processing elements, be they coordination, review, or communication control, are justified if the delay they impose is accompanied by a reduction in error, whether of accuracy, understanding, or correctness. In effect, then, we must determine an optimum point on the delay - error tradeoff curve indicated in Figure 4. Here we hypothesize that as administrative processing increases, delay, of course, goes up. Error tends to decrease up to a point at which an excess of administrative elements might well tend to increase error, as indicated by the dotted line. Our general method of attack is, then, the development of individual element and overall system characteristics by measurement of delay and error in operating headquarters situations.

Before proceeding to the measurement techniques themselves, it is necessary that we introduce the notion of information categorization - clearly the information being transmitted by the system is not homogeneous, nor are the system operating characteristics independent of the character and content of the information being transmitted. For example, the existing system employs a precedence assignment to characterize the intrinsic urgency of a communication. This precedence assignment in turn determines, in part, the system operating characteristics for the particular communication. The information characteristics we have chosen to employ in our investigation are urgency, importance, and policy status. All communications subjected to our analysis are first characterized as to content, and then are assigned a three factor



ERROR-DELAY TRADEOFF

FIGURE 4

rating in terms of their relative importance, urgency, and policy status. Operating characteristics are then developed for sets of homogeneous communications having like values of all three.

Having discussed the conceptual background of our work, it is now possible to turn to the measurement program itself. Measurement of any kind in an operating headquarters is quite difficult. The program must be conducted with a minimum of interference with the organization's mission, and the investigator must be certain that neither his presence, nor the instruments he employs, disturb the system sufficiently to cause false results. For example, an occasional message marked "test" is not an acceptable instrument, because there is very good reason to believe that such a message will be handled in a unique fashion, and there is no way to test for this disturbance. On the other hand, sampling a continuous sequence of say twenty messages, randomly selected from the regular traffic flow during normal headquarters operations, is considerably better, because the system can be expected to return to its steady state after the first few, and the use of reasonably large sequences permits statistical tests for the presence of disturbance.

In general, the measurement of delay is rather straightforward, and involves techniques for securing in and out times of a series of messages at the element in question. Error measurement is somewhat more complex, involving as it does the development of a true error scale. For example, it is entirely possible that a system element which apparently reduces error by correcting grammar in outgoing

messages may actually be increasing true error. This is particularly true of  $E_U$  (Errors in understanding), since a grammatically incorrect colloquial form, or a common cliché may, in fact, be quite understandable. Another complicating factor is the measurement of error for elements whose function it is to detect rare, but serious, errors. Here, the probability may be sufficiently small to escape detection unless extremely large samples are selected for analysis. In this case, the cost of sampling forces the use of critical incident and historical analysis techniques to supplement the actual, or de facto, measurement of error control.

Rather than attempt to cover in brief the many measurement techniques we have developed for specific aspects of the problem, I would like to review in some detail one of the more widely used tools we have found to be quite successful, orange copy. Its employment is quite simple. Pads of pre-numbered, distinctive orange onion skin sheets, in suitable kits, Figure 5, are distributed to properly briefed, selected secretaries throughout the headquarters. The secretaries are asked to type a carbon on the orange paper of every outgoing communication they prepare during the study period, and to mark the orange copy number on the official file copy. They are cautioned to prepare copies of each draft and revision, and not to destroy any orange copies. The pre-numbering of the orange sheets helps to control this. At one-hour intervals, our representative visits each girl and collects all orange copies for the preceding hour. In this way, we have the time the message was typed,

012  
FIL COPY

• Fil

**SECRETARY KIT**

## FIGURE 5

Secretary

**AGENTS - TIPS IN THE OIL STUDY**

**Orange Copy**

1. Please prepare an FBI orange copy of everything you type relative to an unclassified outgoing official communication addressed outside of OCS&G.

2. If the communication is classified up to and including Secret, do not make a copy, simply mark a "C" or an "S" on a blank P/L message sheet. (Top Secret is excluded from this program.)

3. It is vital that you prepare an orange copy (for classified, a blank orange) for each and every draft, revision, and retyping. Do not destroy any orange copies even if the communication is never actually sent out. Remember, the study is not concerned with you or your unit as such but with army communications as a unit.

**PTL NUMBERING**

The basic control element of the study is the PIR. It is therefore imperative that you master it in two places.

- 1) In the oval space on all orange -tion, be classified and unclassified. Every orange -ty must therefore have a fil. #
- 2) In the lower right corner on the face of the official yellow file -ty.

This number, which will always be a six digit number beginning with one, will be found stamped in red in the back of the incoming communications to which the outgoing is a reply. If there is no outgoing communication, or if the number is missing, the Action Officer will furnish you with a PIL No. from a file in his possession. Do not confuse the PIL No. with the blue serial number beginning with one, five, stamped on the orange copy.

**Expos**

Orange copies must be used in serial order, please do not begin a new table until the Orange is exhausted. Please do not give orange copies to, nor borrow them from, other agencies since they are critical to you. Our representatives will use this you are provided with in additional paid as required. We will also accept completed orange copies periodically.

If you have any information, please contact me at 1-800-441-1110 or 1-800-441-1111.

U.S. DEPT. OF JUSTICE

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to the nearest hour, without requiring people in the headquarters to mark for themselves times which are possibly biased. At various key points in the system, as, for example, division chief's office or a message center, we station observers with numbering stamps who stamp coded numbers on the official file copy of each outgoing communication. The coded number, which is changed at regular intervals, is actually a time stamp, but without the seriously upsetting presence of strangers time-stamping documents in a headquarters. After the message has left the headquarters, we intercept the official file copy of the message before it is returned to the various file rooms. We match the orange copy and the official file copy, using the orange copy matching number, and make a photoprint of the file copy. We now can readily measure both elapsed time and de facto control.

In the example shown in Figure 6, we have the orange copy on the left and a photo print of the official file copy on the right. Our coded date-time number on the orange copy indicates that it was typed on 16 June at 1430. The first two date-time numbers on the file copy indicate times at intermediate points while the last number indicates that the message was ready to be turned over to the center on June 17 at 1400 hours, an elapsed time of seven and one-half working hours. The partial updating in ink of the date-time entry on the file copy which was made at some intermediate point, emphasizes the necessity for independent means to check times such as is provided by the orange copy technique. From the file copy, we see that five persons, in

**MATCHING NUMBERS**

102100

UNCLASIFIED

102100

UNCLASIFIED

17 0930

NOTE  
CHANGE  
IN TIME

141808

121811

211812

DATE - TIME NOS.  
(17 JUNE 1400)

**DATE - TIME NO.**  
(16 JUNE 1430)

UNCLASIFIED

211707

UNCLASIFIED

UNCLASIFIED

102100

UNCLASIFIED

102100

UNCLASIFIED

17 0930

NOTE  
CHANGE  
IN TIME

141808

121811

211812

DATE - TIME NOS.  
(17 JUNE 1400)

**USE OF FIL ORANGE COPY**

## FIGURE 6

addition to the writer, initialled this message. Comparison of orange copy and file copy indicate that, in this particular case, the de facto error reduction for which the Army traded eight hours delay time was zero.

At certain headquarters, we have supplemented this technique to secure information about the Action Officer's use of other communications media, internal telephone, face-to-face, buck slip, etc., to secure concurrence and approval. We do this by stamping FIL control numbers on incoming communications, and by asking the Action Officer through the medium of the Action Officer kit, shown in Figure 4, to fill out for each contact a brief contact slip, basically a simple check-off questionnaire keyed to the FIL control number of the communication. In this case, we ask the secretary to mark the FIL control number on the orange copy and on the official file copy. This gives us a complete incoming and outgoing sequence of:

- a. elapsed time in various system elements,
- b. the content of both the incoming and outgoing communications,
- c. the changes introduced by the various elements,
- d. the informal coordination and other internal communications required.

Although the large scale data collection under this program is just beginning, it is possible to indicate the direction of our preliminary findings.

In general, most internal headquarters communication system elements do not appear to secure error reductions commensurate with the delay they



impose. As a matter of fact, the repeated multiple inspections a communication undergoes to detect very low probability real errors, is suggestive of an ordnance factory firing all the ammunition it produces to make certain that the lots are of satisfactory quality level. In the ordnance case, it has been possible to adopt sampling inspection schemes which by monitoring process stability, in the statistical sense, can guarantee any desired average quality level without firing all the ammunition. Unfortunately, the establishment of statistical control schemes for communications is not as simple. Current quality requirements on messages are designed to insure that all communications conform to headquarters policy, and, in fact reflect the latest thinking of the commander. It is, however, reasonable to suggest that once we have developed the specific data on element operating characteristics, it will be possible to design realistic control techniques, using sampling schemes and by-product copies, which do not impede the actual message flow. Such control techniques coupled with optimum automation will make possible a significant decrease in system delay while insuring the maintenance of the desired quality level. Clearly then, the analysis and improvement of internal headquarters communications systems is a necessary concomitant to electronic development programs in the modernization of the global communication system. For only by properly matching man, machine, and organization, can we bring remote military staffs closer together to improve their timely mutual understanding and overall effectiveness.

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